Data Requirements for Coastal Project Planning, Engineering, Construction, and Operations

Heidi Moritz

Portland District

86TH COASTAL ENGINEERING RESEARCH BOARD MEETING

San Diego, California

3 June 2009

- **Data use/needs survey (Coastal Working Group)**
- **Coastal engineering work and data types**
- **Survey Results**
  - Data Availability and Quality Issues
  - Spatial, Temporal, Analysis Scales of Data
  - Data Management, Archiving and Sharing
  - Changing Requirements
  - Key areas of need
- **National Data Collection Programs**
  - Coastal Field Data Collection (CFDC)
  - National Coastal Mapping Program (NCMP)
- **Ideas for action**

Data Use / Needs Survey

- **Survey idea** - CWG monthly phone call (organized by John Winkelman), developed and distributed to the coastal engineers at coastal districts

- **Coastal Working Group Sub-committee:** (Heidi Moritz, Lynn Bocamazo, Monica Chasten, John Winkelman, Bill Birkemeier)

- **100% response from coastal districts**
  - Topic is relevant
  - Focused group of professionals

Survey Layout

26 Data Use Questions

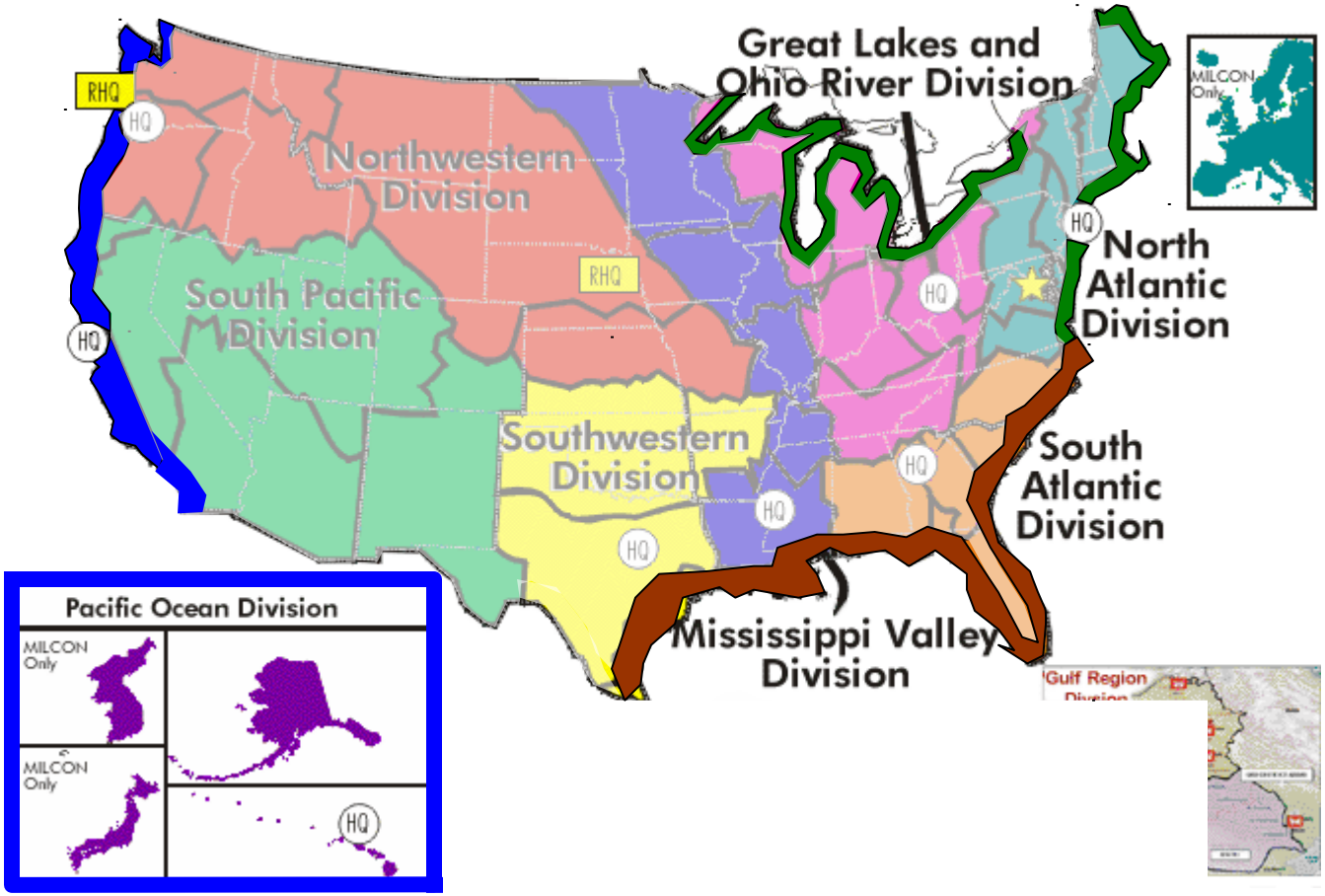
Office Symbol	Division	District	1. What types of coastal projects do you have? (i.e. shoreline protection, beach nourishment, shallow draft harbors, deep draft harbors, recreation, environmental restoration, etc.)
LRC, LRB	Great Lakes and Ohio River Division	Buffalo, Chicago	shoreline protection, beach nourishment, shallow draft harbors, deep draft harbors, recreation, environmental restoration, confined disposal facilities, navigation channels dredging projects
LRE		Detroit	Shore protection, Re-hab of Navigation Structures (Shallow and Deep Draft, Sediment Transport Studies, Dredged Sediment Placement Studies, Inner Harbor Wave Analyses, FEMA Flood Elevation Determination, Lawsuit Defense Studies
NAE	North Atlantic Division	New England	Shoreline protection and inundation prevention, coastal structure repair, beach nourishment, shallow draft harbors, deep draft harbors, recreation, environmental restoration, confined disposal facilities, navigation channels dredging projects
NAN		New York	shoreline protection (storm damage reduction), beach nourishment, shallow draft harbors, deep draft harbors, ecosystem restoration, intrscoastal waterways, breakwaters, coastal inlets
NAP		Philadelphia	Hurricane and Storm Damage Reduction projects (including 10 beach nourishment projects), coastal structures (seawalls, jetties, revetments), shallow draft navigation, submerged breakwaters, environmental restoration
NAB		Baltimore	Shoreline Protection; Beach Nourishment; Shallow draft navigation, environmental restoration, Sand bypassing
NAO		Norfolk	Storm damage reduction, ecosystem restoration, beach renourishment, shallow and deep draft navigation projects
SAW	South Atlantic Division	Wilmington	Shoreline protection, beach nourishment, deep draft harbors, shallow draft channels, and environmental restoration.
SAW		Charleston	Shoreline protection, beach nourishment, deep draft harbors, shallow draft channels, and environmental restoration.
SAS		Savannah	Deep Draft Navigation Harbors, Beach Renourishment, Environmental Mitigation/Restoration, Dredged Material Disposal Areas, Shallow Draft Waterways, Flood Damage Reduction
SAJ -EN		Jacksonville	All of the above.
SAJ -PD		Jacksonville	all of the above; mainly shore protection with beach nourishment. hard structures used to a lesser extent. current construction of hard structures is to maintain beach fill in place. Navigation projects include both deep and shallow draft navigation and Intra Coastal Waterway. Navigation: deep draft harbors at 5 major cities and various shallow draft projects as well as the Gulf and Atlantic Intra Coastal Waterways.
SAM		Mobile	Shoreline protection, beach nourishment, deep draft navigation harbor, restoration.
MVN	Mississippi Valley Division	New Orleans	Beneficial Use, Marsh restoration and protection, shoreline protection, Freshwater and sediment diversions, deep draft navigation channels, locks, gates, barrier island restoration, hydrologic restoration, sediment trapping, sand mining, sand management
SWG	Southwestern Division	Galveston	Coastal projects in SWG include coastal storm damage reduction, ecosystem restoration, deep-draft and shallow-draft navigation, and flood risk management. The coastal storm damage reduction project also takes into consideration a recreation aspect.
SPL	South Pacific Division	Los Angeles	All of the above including shoreline protection, storm damage reduction, navigation, recreation, ecosystem restoration.
SPN		San Francisco	Shore Protection, Flood Control, Shallow Draft Harbor, Deep Draft Harbors, Environmental Restoration
NWP	Northwestern Division	Portland	Deep draft and shallow draft navigation channels, rubblemound jetty navigation entrances, small boat harbors, riverine and estuary pile dike systems, shoreline erosion and protection, open water dredged material disposal sites, environmental restoration, shoreline/coastal flooding
NWS		Seattle	Shallow draft harbors, deep draft harbors, environmental restoration, beach nourishment
POA	Pacific Ocean Division	Alaska	shore protection, deep draft navigation, shallow draft harbor, flood damage reduction
POH		Hawaii	shoreline protection, beach nourishment, shallow draft harbors, deep draft harbors

2 Summary spreadsheets compiling input 21 coastal districts

15 Data Types

Office Symbol	Division	District	Beach Profiles		
			Sources of Data	Problems Encountered	Related Data Needs
LRC, LRB	Great Lakes and Ohio River Division	Buffalo, Chicago	SHOALS in-house surveys contract	SHOALS - inconsistent coverage due to turbidity and breaking waves	
LRE		Detroit	Contractors. D&M	Inconsistent datum	Denser coverage around harbor
NAE	North Atlantic Division	New England	SHOALS/CHARTS in-house surveys contract	SHOALS/Charts - inconsistent coverage due to turbidity and breaking waves	
NAN		New York	In house (survey Branch) Contract Engineering Staff Local University	timeliness of data collection increasing costs difficulty in getting immediate post-storm profiles (for model calibration)	LIDAR vs. short profiles
NAP		Philadelphia	Contractor, in-house non-Federal sponsor (DE) University (Stockton)	environmental windows (not completing profiles) accuracy in surf zone	technologies that develop accuracy surveying the surf zone
NAB		Baltimore	A-E	Control issues on occasion	
NAO		Norfolk	Local sponsor, Local Universities		
SAW	South Atlantic Division	Wilmington	Annual monitoring 2 projects.		
SAW		Charleston	University State of South Carolina contractor	incorrect equipment setup	
SAS		Savannah	Construction Contractor Surveys In-House Survey Crews	Reliability due to potential conflict of interest Due to the large tidal range, it is difficult to get both hydrographic and topographic surveys during a reasonable time frame.	
SAJ -EN		Jacksonville	AE's, In-house	none	
SAJ -PD		Jacksonville			
SAM		Mobile	Lidar, In-house Bathymetric Survey, State databases	Inconsistent vertical datums. Issues with post processing.	
MVN	Mississippi Valley Division	New Orleans			
SWG	Southwestern Division	Galveston			
SPL	South Pacific Division	Los Angeles	hydrographic and nearshore surveys Old Corps and BEB records Old County records BEACON/SANDAG Organization of Local Gov't	datum conversions, accuracy not geo-referenced ambiguous alignment and zero location inconsistent datums (vertical) and local datums	Data to Produce Accurate Beach Profiles, long-term records that are geo-referenced need frequent enough capture seasonal and long-term trend Comparing historic beach profiles with current profiles and LIDAR
SPN		San Francisco	Survey Contractors NOAA Coast & Geodetic Survey USGS Surveys In-house staff	Datums Variability in survey techniques or assumptions Poor understanding of the true accuracy of various survey techniques	Datums; transect reference point Risk and Uncertainty Lidar capable software and computer power
NWP	Northwestern Division	Portland	in-house crew, contractor State governments, local agencies photogrammetric methods, lidar	some datum and control issues ground control setup expensive	more regional coverage needed after storms
NWS		Seattle	District WA Dept. Ecology	Data is unavailable without requesting	Post-storm monitoring surveys of erosional hotspots
POA	Pacific Ocean Division	Alaska	Contract surveyor	survey control. vertical datum changed relative to survey due glacial rebound/and or sea level rise	new monuments and tide gaging to update old monuments
POH		Hawaii	A/E Contracts	Cost is extremely high in remote locations. Datum issues.	In-house resources and tools would be beneficial.

Regional Groupings



Ideas for Action

- Standardized and accessible **data storage platform** (consistent into the future, adaptive, robust, discoverable, not program-specific)
- Consistent national guidance and **data collection standard** with identified POC's (ITL lab, CWG regional POC's)
- Identify **regional and time-scale issues** and needs
  - Regional cooperation and knowledge of data collection efforts would encourage more data sharing and less data collection overlap
  - Potential identification of "Keepers of Data" (i.e. water level, wave, profile, etc.) to maintain consistency and access
- Identify data needs to support **multiple scenario, risk-based, and performance-based** investigations
- Identify data collection needs related to **projects / people at risk**
- Move toward **consistent base level funding** of long-term data needs
- Survey helps summarize current status. **Additional steps needed to address:**
  - What data already exists? What data do we <u>really</u> need and why? What problems are we trying to solve? What level of analysis is required?

Coastal Engineering Work and Data Types

- **Structures:** *(above and below water surveys, post-storm surveys, economic data, damage functions, water levels, wave heights, quarries)*
- **Harbors/Channels:** *(dredging volumes and locations, channel depths, project economic data, bathymetry, wave reduction, aerials)*
- **Beach nourishment:** *(Beach profiles, post-storm data, sediment, monitoring data, profile volumes, transport paths and rates, borrow sites)*
- **Shoreline protection/flooding:** *(topography, foredune elevations, infrastructure elevations, post-storm overtopping and damages, aerials)*
- **Economic and project performance:** *(commerce, vessel usage, operational windows, safety, historical performance)*
- **Environmental assessment and monitoring:** *(inundation, salinity, hydraulic data, endangered species, water quality)*
- **Ocean Dredged Material Disposal Sites:** *(bathymetry change, transport paths and rates, disposal volumes, wave transformation)*

Survey Results

Data Availability

- **Data Sources:**
  - in-house crews, state and federal agencies, contractors, universities
  - National Data Collection Programs (CFDC, NCMP, MCNP, FRF)
  - Federal Agencies: NOAA, USGS, Air Force, Coast Guard, DOD
- **Data Availability Problems:**
  - Historic or previously collected data
  - Wave Data:
    - Updated Wave Information Study (WIS) needed
    - Directional wave data; nearshore, sheltered and remote areas
    - Extreme event gaps
  - Lack of real-time, archived water level gauges
  - Outdated offshore and nearshore bathymetric data
  - Sediment and hydraulic data
  - Structure and shoreline response data, project performance data
  - Ice data; strength, mobility, thickness

Data Availability Quotes

- Data availability is always an issue in the Pacific Ocean. POH covers a lot of remote locations where there isn't much legacy data to count on.
- Some obscure local, state or other federal agency is probably collecting data we don't know about that we could use.
- There is very little information for the southern half of the coast of South Carolina, either historic or current.
- Wave data for Olympic Peninsula. There are currently no active wave buoys and recent hindcasts are still in development.
- Lack of directional wave data along New England Coast. NOAA GEODAS data for offshore and near shore bathymetries is very old as well. Too few real time/archived water level gages.

Using Physical Models to Supplement Real Data

EXTENSIVE PHYSICAL MODEL STUDIES
Recently completed by ERDC (Drs. Melby / Ward)
Wave “damage” functions for rehabilitation alternati

Data Quality Issues

- Some WIS data outdated, Pacific Ocean issues
- Wave data gaps or capturing extremes of data
- Accurately capturing wave direction
- Aerial photograph quality and control
- Lidar data problems; insufficient coverage, inaccurate readings, turbidity, wave breaking
- Lack of lidar penetration below water in many areas
- Vertical and datum control issues

Spatial, Temporal, Analysis Scales

- **Temporal:**
  - Historic
  - Real-Time, Pre- and Post-storm
  - Annual, Periodic, Infrequent
- **Spatial:**
  - Project feature
  - Project, Regional
  - Above / below water
  - Nearshore / Offshore
- **Analysis Levels:**
  - Inspections, Monitoring, Damage /Response
  - Project Performance, Design and Calibration
  - Risk and Reliability, Environmental Impact

Temporal / Spatial Data Quotes

- Almost all data is collected on a project by project basis because that is how we are funded. We mainly rely on data from others and supplement to the best we can.
- Timing of data collection can often be a problem for projects that are fast tracked. Ideally we'd like to collect data during the storm season and over a period of time sufficient to record a range of events. But a project may not have sufficient time to wait for this data to be collected.
- Regional data collection, helping the districts with that cross-agency data collection, standardizing data requirements for studies, ….
- The answers we need are usually in complex systems requiring more data

Analysis Scales of Data

- Project condition for projection of budget needs
- Assessment of long-term maintenance demands
- Project performance for prioritizing of infrastructure demands
- Input data to complex numerical models and reliability analyses
- Calibration and verification of model application (provides essential support during review process)
- Immediate post-storm imagery and damage assessments
- Risk and reliability analysis, Beach-Fx

Analysis Level Quotes

- I'm not sure that the level of data detail that could be expected is necessary when we look at the final constructed product (a big pile of sand with most dimensions ultimately shaped by the sea)… Given the rough resolution of the final product, will the significant increase in data requirements alter conclusions that could have been reached with a simpler model?

- Additional data has been needed to feed more numerical models during feasibility studies, that's been the biggest change,…

Data Management and Archiving

- Lack of data management strategy and funding support
- Attempts have been made to provide GIS-based environment, local network site
- Attempts to use eCoastal have run into project organization problems vs P2
- Need for a storage/management platform – P2 friendly, robust, multiple use, can be used with existing and future organizational platforms
- Search tool vital; data must be discoverable

Data Management Quotes

- The District lacks a data management strategy and funding support.
- Our biggest problem is data management and archiving, finding the people and time to do it, so everyone at the District knows what was collected, where it is store and how to use it.
- Hate to admit, but we think our data management is below standard, we are trying to improve, project-based data collection is the largest road block.
- Most data is stored on local District servers for one-time use. Very little data is disseminated.

Data Sharing

- Data sharing occurs somewhat with local sponsors, state agencies, universities ;
  - can be cumbersome and time consuming with different platforms
  - potential for more sharing and reduction of data overlap
- Lack of knowledge of data being collected
- Need to provide a way to catalogue and discover data
- Inconsistencies in data format, lack of metadata
- Data archiving needs to be in purest, and most accessible mode for multiple use
- Potential for identified data keepers amongst federal agencies

Changing Requirements

- **Process:**
  - Multiple organizations collecting data
  - Quantity and Density of Data (multi-beam, lidar, digital photos)
  - Higher levels of reporting and review requirements
  - Higher levels of environmental monitoring and justification
- **Technical:**
  - Environmental change (sea level, storminess)
  - Improved and Advanced Models (2D vs 3D)
  - Risk and reliability, performance-based, multiple scenario approach
  - Larger system scale data needs
  - Level of detail needed

Climate Change Issues

- Some remote areas have no historical record to compare current and projected conditions (Great Lakes?)
- Statistical tools to synthesize trends; data mining tools
- Compilation of economic / consequence data, tools needed to assess degree of relevance for Corps projects
- Education more important than additional data collection; how do we deal with range of estimates?
- Storm frequency/intensity and potential sediment budget impacts

Climate Change Quotes

- How does climate change impact the typical stationary extreme statistical analysis for waves, storm surges, etc? This has significant implications on structure design
- At remote sites in Alaska there is no long term water level data so it is difficult to determine if the site is influenced by glacial rebound or sea level rise.
- Focus has been on oceans (sea level rise) with no consensus made on Great Lakes.
- Much emphasis is being placed on potential general water level changes. More investigation needed on changes in frequency and intensity of storm events including any changes to infragravity surge…

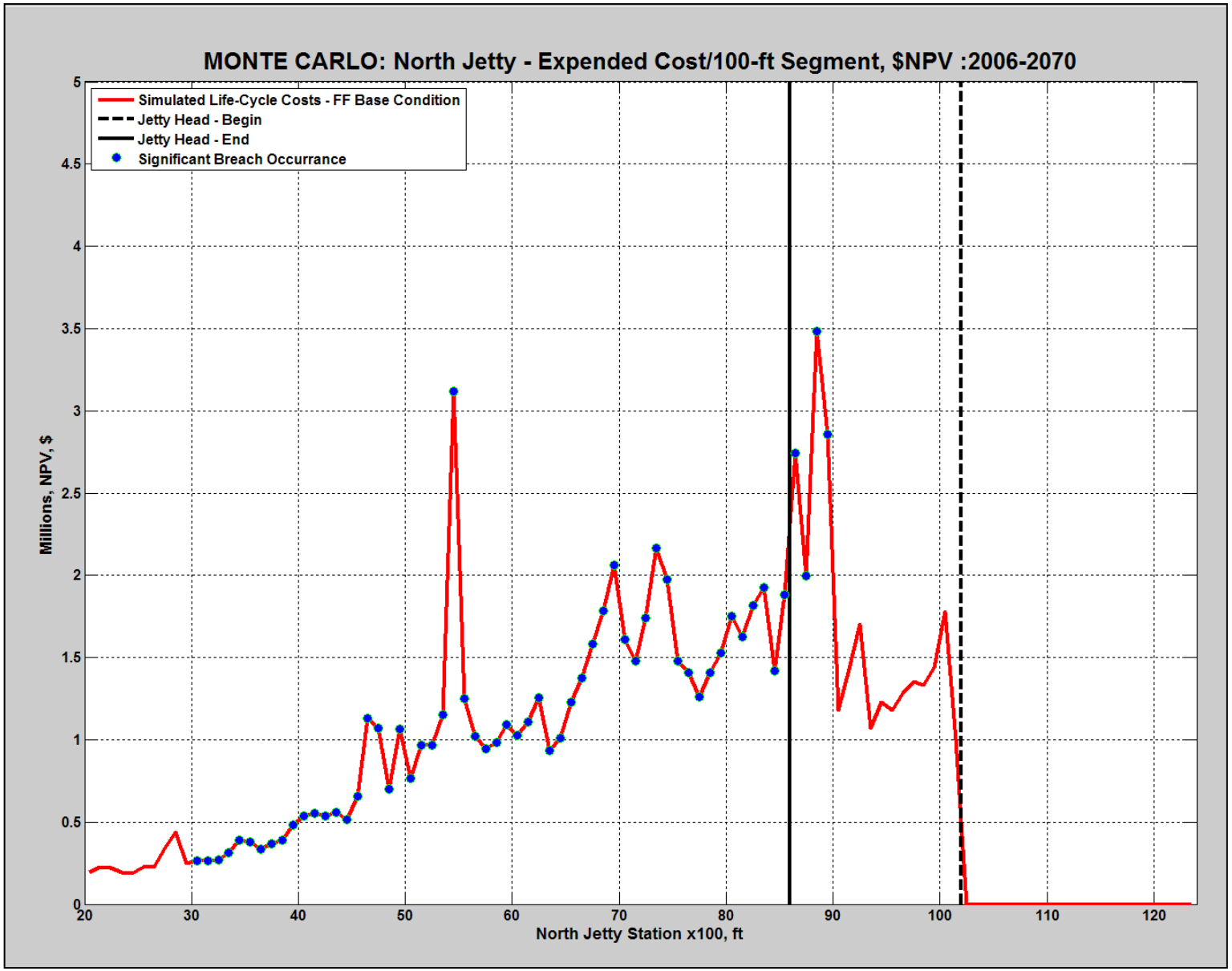
Risk and Reliability Issues

- Damage and failure functions needed for full range of structure types
- Economic data to set up statistical life cycle analysis models
- Performance data to establish accurate reliability functions; shoreline and structure response for model calibration
- Methods to interrogate data to highlight longterm variability trends
- Flood mapping support for FEMA
- Tools to prioritize rehabilitation of structures
- Risk and reliability application examples for coastal projects (current inland navigation examples are less useful)
- Particularly with respect to climate change issues, guidance on describing risk and long term project/economic impacts

Risk and Reliability Quotes

- Guidance and examples regarding determination of risk and uncertainty for various data types is needed (datums, wave, water level, wind, turbidity, etc).
- Data requirements of Beach-fx can be significantly greater than past economic planning models.
- Continually increasing requests for risk and reliability assessments and impacts of no action; ranking amongst other projects. There should be a "defined" level of detail for various levels of data calls…
- When big storms are coming we need to get beach surveys before and right after the storm. With a portable RTK and virtual reference we could do this, if we got funding for the equipment.

Life Cycle Model Results – Major Rehabilitation



Larger System Scale Data Needs

- Harbor structure condition for Great Lakes systems
- Directional wave data and storm trend analysis
- Multiple beach and inlet surveys for sediment budget and littoral cell analyses, RSM plans
- Large scale modeling effort of San Francisco Bay with coordinated data collection
- Alongshore and cross shore transport estimates
- Biological and environmental data for habitat and ecosystem studies
- Potential changes in regional processes that could impact multiple projects
- Data collection may be a longer term activity that cannot be conducted adequately by the time a project is started and scheduled

Increasing Data Requirements

- Level of data and analysis should be related to level of risk and consequence associated with answer.
- Structure damage and response, project damage and response data often lacking. Can be difficult to obtain that from historical records due to sparseness of structure and project surveys
- Placement of dredged material in the nearshore, more temporal and spatial data is needed
- Increasing environmental reporting requirements: endangered species, total daily maximum loads, evidence of no-impact

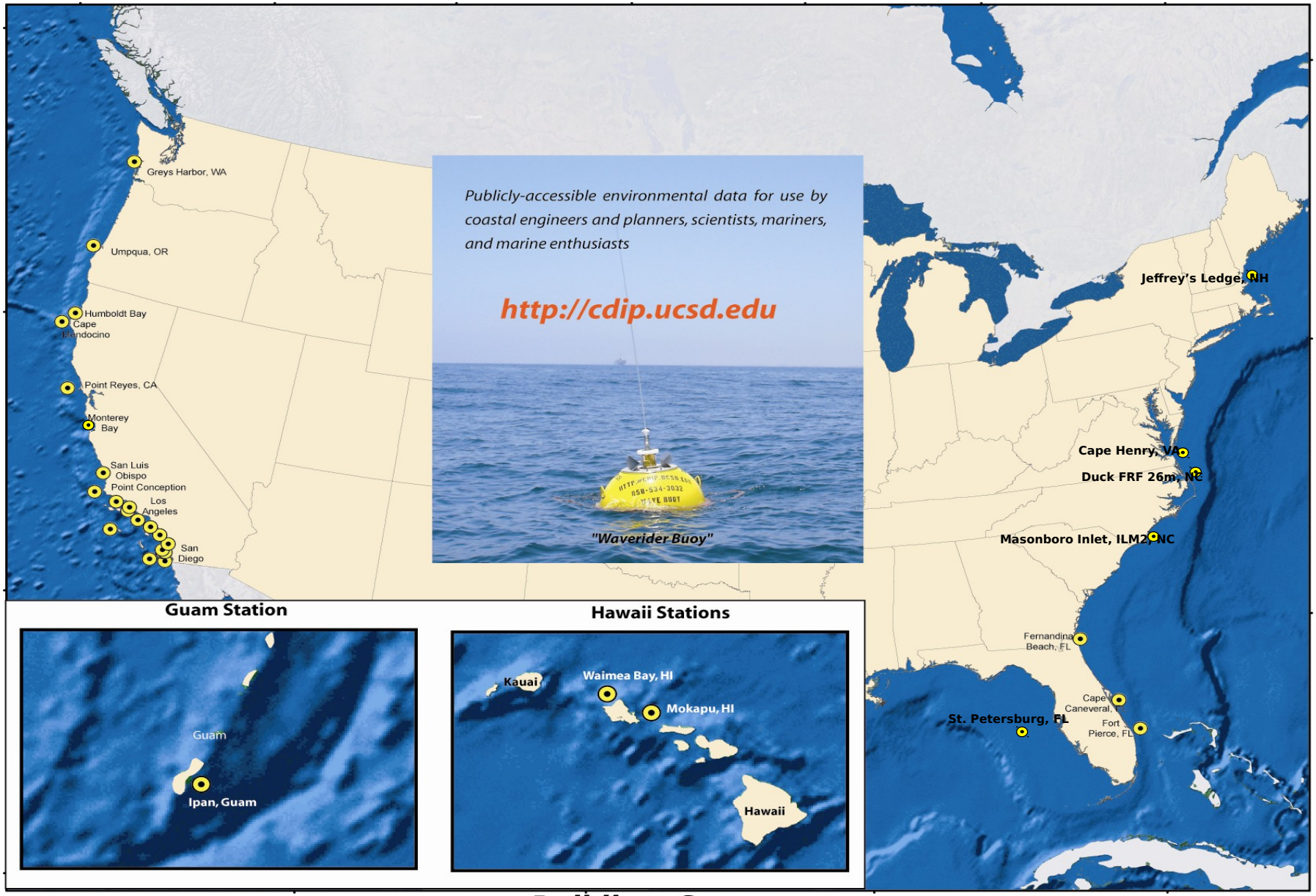
Key Areas of Need

- **Robustness of Data Archiving** (i.e. purest storing or data, usable by multiple programs, easily accessible by multiple users)
  - Data collection standards, formatting, data platform and sharing practices
  - Datum and standard consistency; example scopes
- **Education for districts** to help them prioritize data collection for upcoming challenges like climate change, regional storm data sets, etc.
  - Coastal project risk and reliability examples
  - Data mining and statistical analysis tools that portray trends, variability, and risk; accessing/Using Historical and existing Data
  - System response data; bathymetry, shoreline, structures, project performance, economic consequences
- **Rapid post-storm survey tools; regional coverage after storm events**
- **Wave and water level data**
  - Sheltered and nearshore areas, remote areas, directional data, capturing of extremes (height, period)
  - Improved and Updated Wave Information Study
- **Data needs that require regional or extended action**: (wave data, water level data, aerial photographs, sediment transport data, shoreline change data)

National Data Collection Programs

- **Some existing national programs that can help**
- **Coastal Field Data Collection** (30+ years of data) (Bill Birkemeier)
  - **Data collection efforts**:
    - Field wave gauging (CDIP with Scripps, NDBC)
    - Wave Information Study (WIS)
    - Field Research Facility
    - Wave modeling efforts
    - IOOS (Integrated Ocean Observing System)
  - Can support a wide range of field data needs with proper funding
  - Typically budgeted at $1.4 M, any additional is Congressional Add
  - Without congressional support, much of program (all of wave buoys) go away

Existing CDIP Locations



National Data Collection Programs

- **National Coastal Mapping Program** (Jennifer Wozencraft)
  - The only national mapping program that provides regional lidar elevation and imagery data along the sandy shorelines of the US at 5 year intervals
  - Navigation business line funding to support RSM and project management
  - Provides data beyond the bounds of navigation projects for the creation of regional sediment budgets to give a regional context to project management
  - Provides repeat data for monitoring of coastal projects and the regions within which they reside

Ideas for Action

- Standardized and accessible **data storage platform** (consistent into the future, adaptive, robust, discoverable, not program-specific)
- Consistent national guidance and **data collection standard** with identified POC's (ITL lab, CWG regional POC's)
- Identify **regional and time-scale issues** and needs
  - Regional cooperation and knowledge of data collection efforts would encourage more data sharing and less data collection overlap
  - Potential identification of "Keepers of Data" (i.e. water level, wave, profile, etc.) to maintain consistency and access
- Identify data needs to support **multiple scenario, risk-based, and performance-based** investigations
- Identify data collection needs related to **projects / people at risk**
- Move toward **consistent base level funding** of long-term data needs
- Survey helps summarize current status. **Additional steps needed to address:**
  - What data already exists? What data do we <u>really</u> need and why? What problems are we trying to solve? What level of analysis is required?